ANSWERS: Interpreting equilibrium expressions using the value of K

1) As the temperature increases, K_c decreases.

The decreasing value of K_c indicates that the reaction is reactant-favoured (i.e. more reactants than products).

When temperature increases, the system responds and decreases the temperature by shifting in the endothermic direction.

Since the increasing temperature favours the reactants, this must mean that the reverse reaction is endothermic and the forward reaction (formation of NH_3) is **exothermic**.

$$\frac{[HI(g)]^2}{[H_2(g)][I_2(g)]} = 46.8$$

$$\frac{[HI(g)]^2}{[0.0190][0.210]} = 46.8$$

2) $\frac{[HI(g)]^2}{3.99 \times 10^{-3}} = 46.8$

$[HI(g)]^2 = 0.187$

$[HI(g)] = 0.432 \text{ mol L}^{-1}$

3 i) PCl_5

ii) The value of K_c is less than 1 / small. This means that the concentration of reactant (PCl_5) is greater than the concentration of products (PCl_3/Cl_2).

iii)

$$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]}$$

$$[PCl_5] = \frac{[PCl_3][Cl_2]}{K_c}$$

$$[PCl_5] = \frac{0.352 \times 0.352}{0.612}$$

$$= 0.202 \text{ mol L}^{-1}$$

4)

$\frac{(0.7)^2}{(0.5)^2.(0.1)} = 19.6$

This value is less than K_c at equilibrium (280) meaning that there are more reactants than products at this stage of the reaction. This means that the equilibrium will move in the forward direction to produce more product, SO_3 and hence allow the mixture to reach equilibrium This value will approach K_c for this reaction.

5)

Kc small OR *Kc* <1: reactants > products

When temperature is decreased: reaction occurs to: reduce decrease in T: favouring the forward, exothermic reaction. A catalyst has no effect on yield: since it increases the rates of forward and reverse reactions equally. When pressure is increased: reaction occurs to: reduce increase in pressure: favouring the forward reaction which reduces the number of moles of gas.

6) The intensity/shade of the purple colour will stop changing

HI is in the highest concentration.
The value of K_c is greater than 1 / large / high. This means that the concentration of products (HI) is greater than the concentration of reactants (H_2 and I_2) / products are favoured/more products than reactants.

- At increased temperature the value of K_c decreases.
- This means that the equilibrium shifts in favour of reactants, ie the reverse direction.
- An increase in temperature causes the equilibrium to shift to favour the reaction that absorbs heat / energy, ie the endothermic direction.
  Hence, the forward reaction is exothermic.

7) At 230°C a brown colour would be observed.

NO_2 is in the highest concentration. The value of K_c is greater than 1. This means that the amount of the products will be greater than the reactants. Therefore the concentration of $NO_2(g)$ will be greater than $NO(g)$ or $O_2(g)$. This explains the dark brown colour, as there is more $NO_2(g)$, which is a brown colour compared with the other two, which are both colourless.

8) $Ag(NH_3)_2^+(aq)$ *K*c is very large (10^7), so concentration of product is high compared to that of reactants (as the product concentration is on top of the ratio).

9) $NO_2(g)$ *K*c is very small (10^{-5}), so concentration of product is low compared to that of reactants (or concentration of reactant is higher) (as the product concentration is the top of the ratio, or reactant concentration is on the bottom of the ratio.)